Daniel Melnick[1,2], Ed Garrett[3], Julius Jara-Muñoz[4]

Quantifying the timing and amplitude of Holocene relative sea level in south-central Chile using geomorphology and stratigraphy

[1]Instituto de Ciencias de la Tierra, TAQUACh, Universidad Austral de Chile, Valdivia, Chile, e-mail: daniel.melnick@uach.cl
[2]Millennium Nucleus The Seismic Cycle Along Subduction Zones
[3]Durham University, Sea Level Research Unit, Department of Geography, Durham, UK
[4]Institut für Erd- und Umweltwissenschaften, Universität Potsdam, Germany

Key words: sea level highstand, Holocene, MIS-5, tectonic uplift rate

Estimating the amplitude and timing of Holocene relative sea level along tectonically-active coasts is challenging because it involves eustatic, isostatic and tectonic components. Here we present estimates of the peak amplitude and timing of the Holocene relative sea-level highstand along ~500 km of the south-central Chilean coast between 33-38S using geomorphic and stratigraphic markers. Using airborne LiDAR data, we mapped the shoreline angle – a geomorphic marker of past sea-level positions –at 83 paired locations including Holocene and MIS-5 marine terrace levels (Fig. 1). The data were collected before the 2010 Maule earthquake (M8.8) that caused meter-scale coastal land-level changes. Elevations of these two markers vary substantially along the coast but are linearly correlated (r^2=0.83) suggesting constant rates of permanent tectonic uplift. The timing of the highstand was estimated from a compilation of 61 radiocarbon and luminescence ages recalibrated and reinterpreted to assess their indicative meaning. We find that the mid Holocene highstand occurred between 4 and 6 cal ka BP. Tectonic uplift rates between 0.1 and 1.5 mm/yr estimated from MIS-5c and 5e terraces (dated with 12 luminescence and 8 cosmogenic nuclide ages; Jara-Muñoz et al., 2015) were subtracted from Holocene shoreline angle elevations to estimate the amplitude of the eustatic component. For an age range of the Holocene highstand between 4 and 6 ka, we obtained mean elevations between 3 and 3.5 m above modern mean tide level (Fig. 2). Our compilation of sea-level index points suggests lower values in the range of 1-2 m. Both estimates are in agreement with ICE-5G model predictions for a range of lithospheric thicknesses. Our methodology may be applied to tectonically-active coasts such as those bordering subduction zones, with implications for assessing coastal hazards under future sea-level rise.

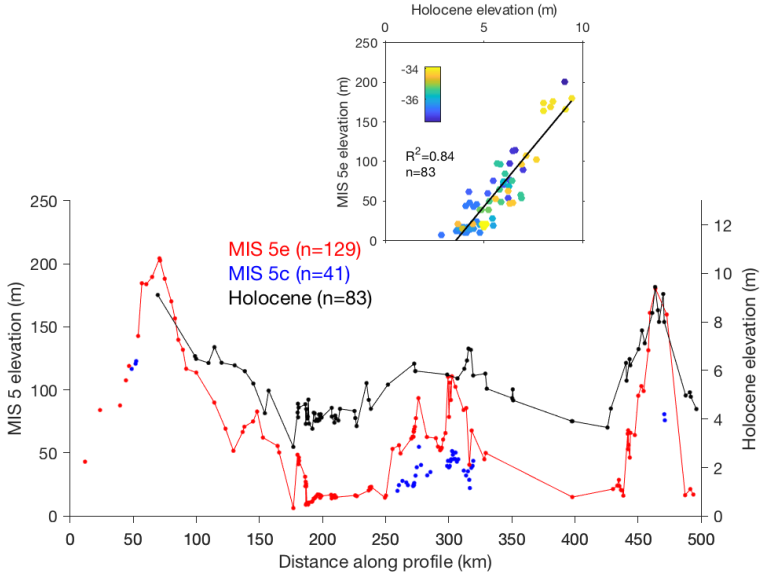

Figure 1. Shoreline angle elevations of marine terrace levels in south-central Chile. Lines show linear interpolations. Inset shows relation between MIS-5e and Holocene levels at collocated sites. Note linear correlation. MIS-5 sites from (Jara-Muñoz et al., 2015).

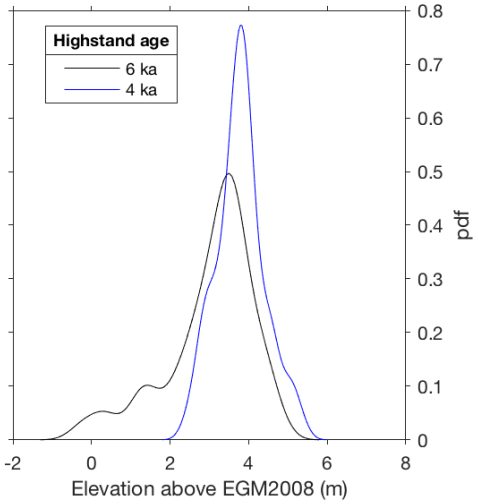

Figure 2. Probability density functions for the elevation of the Holocene sea-level highstand along the south-central Chile coast corrected for tectonic component using MIS-5 uplift rates, for ages of 4 and 6 ka.

Reference

Jara-Muñoz, J., Melnick, D., Brill, D., and Strecker, M. R., 2015, Segmentation of the 2010 Maule Chile earthquake rupture from a joint analysis of uplifted marine terraces and seismic-cycle deformation patterns: Quaternary Science Reviews, v. 113, p. 171-192.